Student Workbook $.30

DIGITAL EQUIPMENT CORPORATION

education

HUNTINGTON II Simulation Program — LOCKEY

computers are for kids — digital — EduSystems—expandable, economical

DIGITAL EQUIPMENT CORPORATION
EDUCATIONAL PUBLICATIONS

A partial list of the publications in the continuing series of curriculum material published by Digital for use with EduSystems and RSTS are listed below. Please inquire directly for prices on classroom quantities.

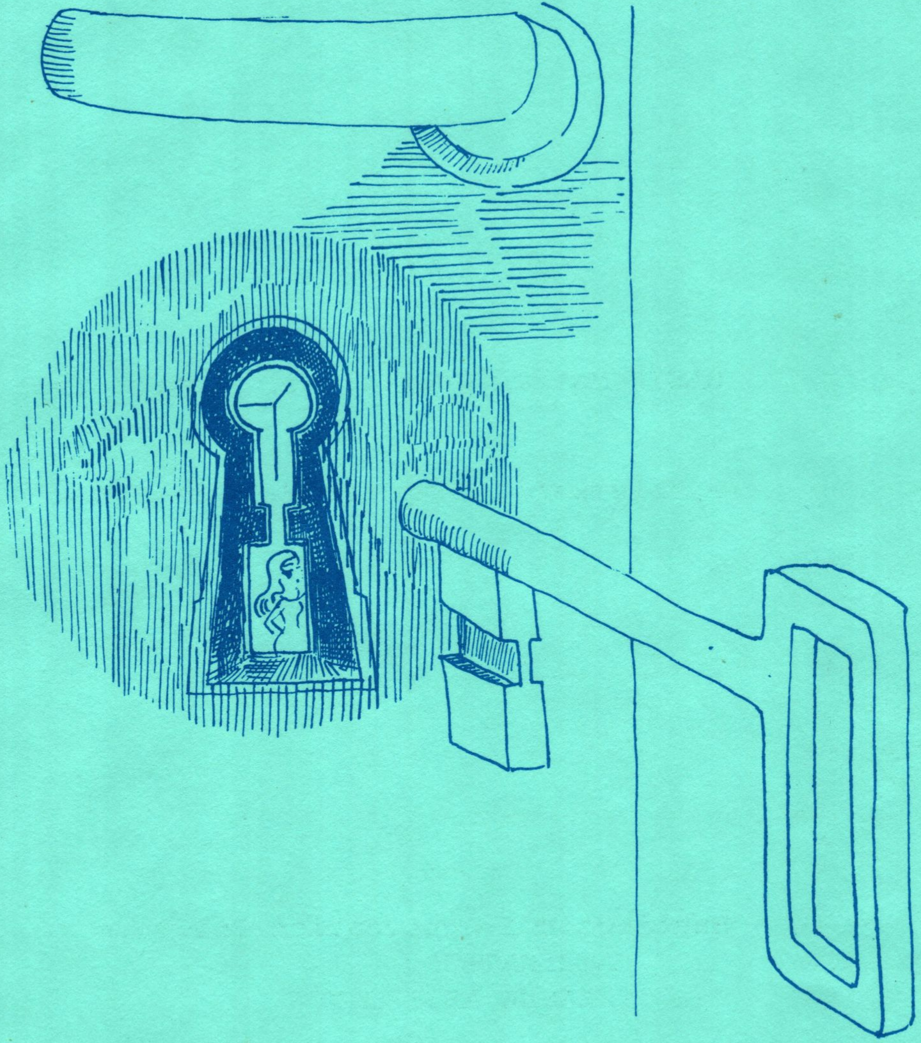
Additional publications may be obtained from:

Software Distribution Center
Digital Equipment Corporation
Maynard, Massachusetts 01754

Population: Self teaching BASIC Workbook	$2.00
BASIC Matrix Operations, Project Solo	$1.00
Problems for Computer Mathematics	$1.25
Advanced Problems for Computer Mathematics	2.00
BASIC Application Programs	
Mathematics I	$1.00
Mathematics II	1.00
Science	1.00
Business and Social Studies	1.00
Plotting	1.00
Huntington I Application Programs	
MATHEMATICS	$2.00
TEACHER ASSISTANCE	1.00
Huntington I Simulation Programs	
BIOLOGY	$1.00
CHEMISTRY	2.00
EARTH SCIENCE	1.00
PHYSICS	2.00
SOCIAL STUDIES	1.00
Huntington II Simulation Modules	
Student Workbook	$0.30
Teacher's Guide	.30
Resource Handbook	.50
Program Paper Tape	1.00

LOCKEY

THE LOCK AND KEY MODEL OF ENZYME ACTION



STUDENT WORKBOOK

HUNTINGTON TWO COMPUTER PROJECT

Copyright C 1971, State University of New York

15 October 1971

The work of the Huntington Two Computer Project is partially supported by the National Science Foundation, Grant GW-5883

Exclusive publishing rights granted to Digital Equipment Corporation.
REPRODUCTION NOT PERMITTED

SECTION I -- STUDENT MATERIALS FOR LOCKEY

In this exercise, you are conducting a simulated experiment in competitive inhibition of the enzyme acetylcholinesterase (a sēt′el kō′lin es′te rās′). This brief section will attempt to give you some knowledge about this exercise.

A. About the enzyme

Acetylocholinesterase acts as an enzyme (organic catalyst) to break down the compound acetylcoline (a sēt′el kō′lēn, lin) into its two halves acetic acid and choline. The simple word equation for this would be:

$$\text{acetylcholine} + \text{water} \xrightarrow{\text{enzyme}} \text{acetic acid} + \text{choline}$$

The enzyme acetylcholinesterase is essential to your body because it is one of the set of enzymes that control the nervous system. Anything that would interfere with the normal action of acetylcholinesterase would lead to death, since the nerves would cease to function. This is only one reason why this enzyme is important.

B. About enzyme function

How does an enzyme do its work? Scientists have not yet completely answered that question, but one of the most useful ideas that have been proposed is the Lock and Key Model of enzyme action.

To understand this model we picture the substrate (the substance the enzyme works on) as being a jagged lock and the enzyme is pictured as a key that fits the lock. The enzyme (key) will only act on those chemicals that are similar in shape to the substrate (lock).

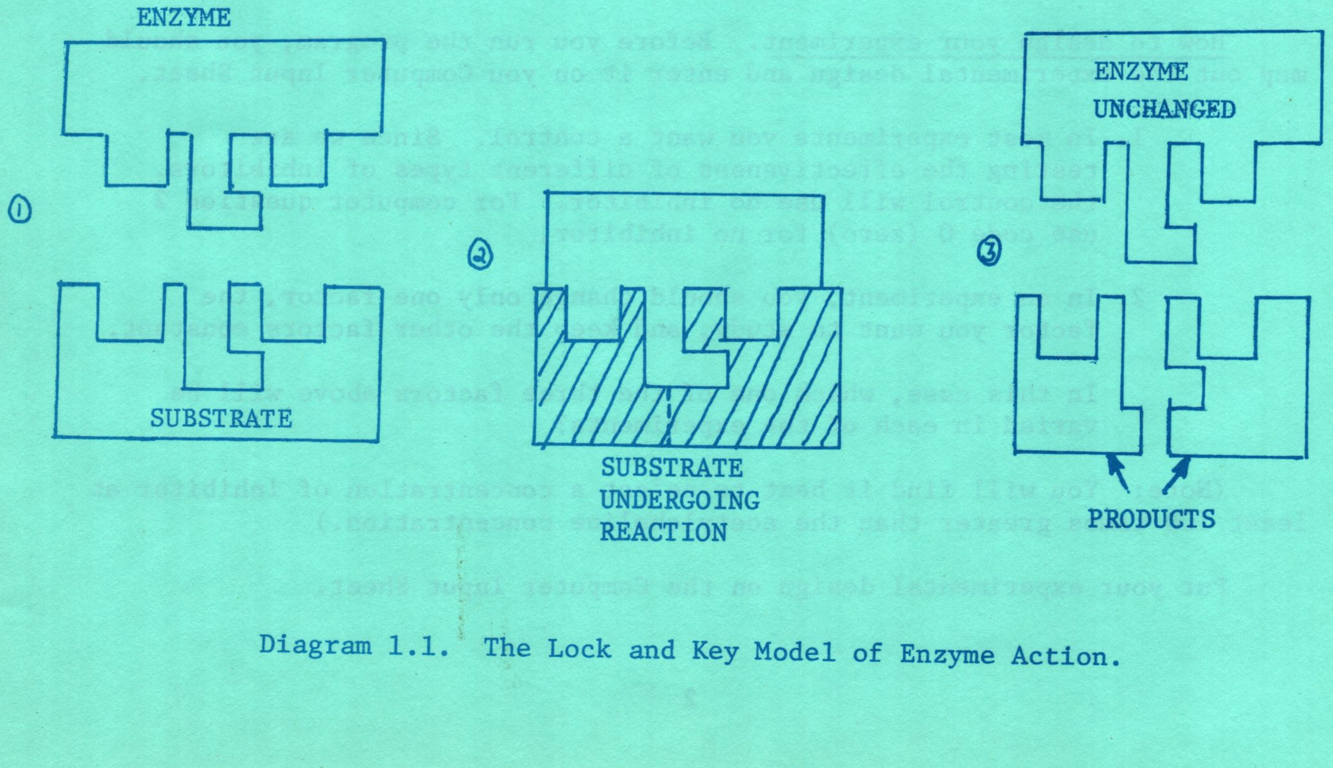


Diagram 1.1. The Lock and Key Model of Enzyme Action.

So we may picture acetylcholine as the lock and acetylcholinesterase as the key. Once the key is in the lock, the enzyme is able to "work on" the substrate (in this case, break it in two). The enzyme then releases the products acetic acid and choline.

C. About competitive inhibition

Normally, according to Lock and Key, the enzyme acetylcholinesterase fits into the acetylcholine and breaks it down into acetic acid and choline.

If we put another chemical into the test tube, one that is similar in shape to acetylcholine, the acetylcholine and the other chemical compete to join up with the enzyme.

If they do get into competition, should more or less acetic acid be produced than normal?

Before you do these experiments, you should have a guess for this question. Such an educated guess is called a hypothesis (hī poth′i sis). During the experiment you should check to see if your hypothesis is correct or incorrect.

D. Running the experiment

Your goal in this experiment will be to determine which inhibitor chemical is most effective.

In the computer simulation you can control:

1. Amount of acetylcholine
2. Type of inhibitor chemical
3. Amount of inhibitor

How to design your experiment. Before you run the program, you should map out the experimental design and enter it on you Computer Input Sheet.

1. In most experiments you want a control. Since we are testing the effectiveness of different types of inhibitors, the control will use no inhibitor. For computer question 2 use code 0 (zero) for no inhibitor.

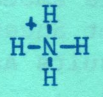
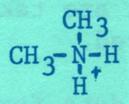
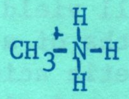
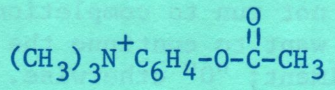
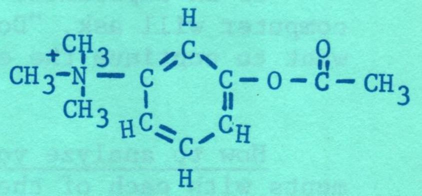
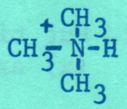
2. In an experiment, you should change only one factor, the factor you want to study, and keep the other factors constant.

   In this case, which one of the three factors above will be varied in each of the experiments?

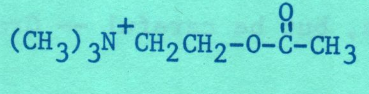
(Note: You will find it best to select a concentration of inhibitor at least 100 times greater than the acetylcholine concentration.)

Put your experimental design on the Computer Input Sheet.

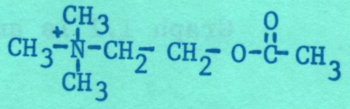
We are going to check the following chemicals for competitive inhibition:

CODE	NAME	CHEMICAL FORMULA	STRUCTURE
1	ammonium	NH_4^+	
2	dimethylamine	$(CH_3)_2NH_2^+$	
3	methylamine	$CH_3NH_3^+$	
4	prostigmine	 $(CH_3)_3N^+C_6H_4-O-\overset{O}{\overset{\|}{C}}-CH_3$	
5	trimethylamine	$(CH_3)_3NH^+$	

For comparison, the atomic structure of acetylcholine is:



$(CH_3)_3N^+CH_2CH_2-O-\overset{O}{\overset{\|}{C}}-CH_3$



How to use the computer. The first question the computer will ask is "Do you wish instructions?" Type "1" if you do, "0" otherwise. You will probably want instructions the first time you run the program.

Since the first run is the control for the experiment, you have to enter only the amount of acetylcholine (0 to 3 millimoles) from your Computer Input Sheet, the code number 0 for no inhibitor, and whether you want your results as a table or as a graph. (Type "1" for a table, "2" for a graph.)

For each succeeding run you will have to input the amount of acetylcholine, the code number for the inhibitor and the amount of inhibitor, all of which are taken directly from the Input Sheet, as well as the data format desired.

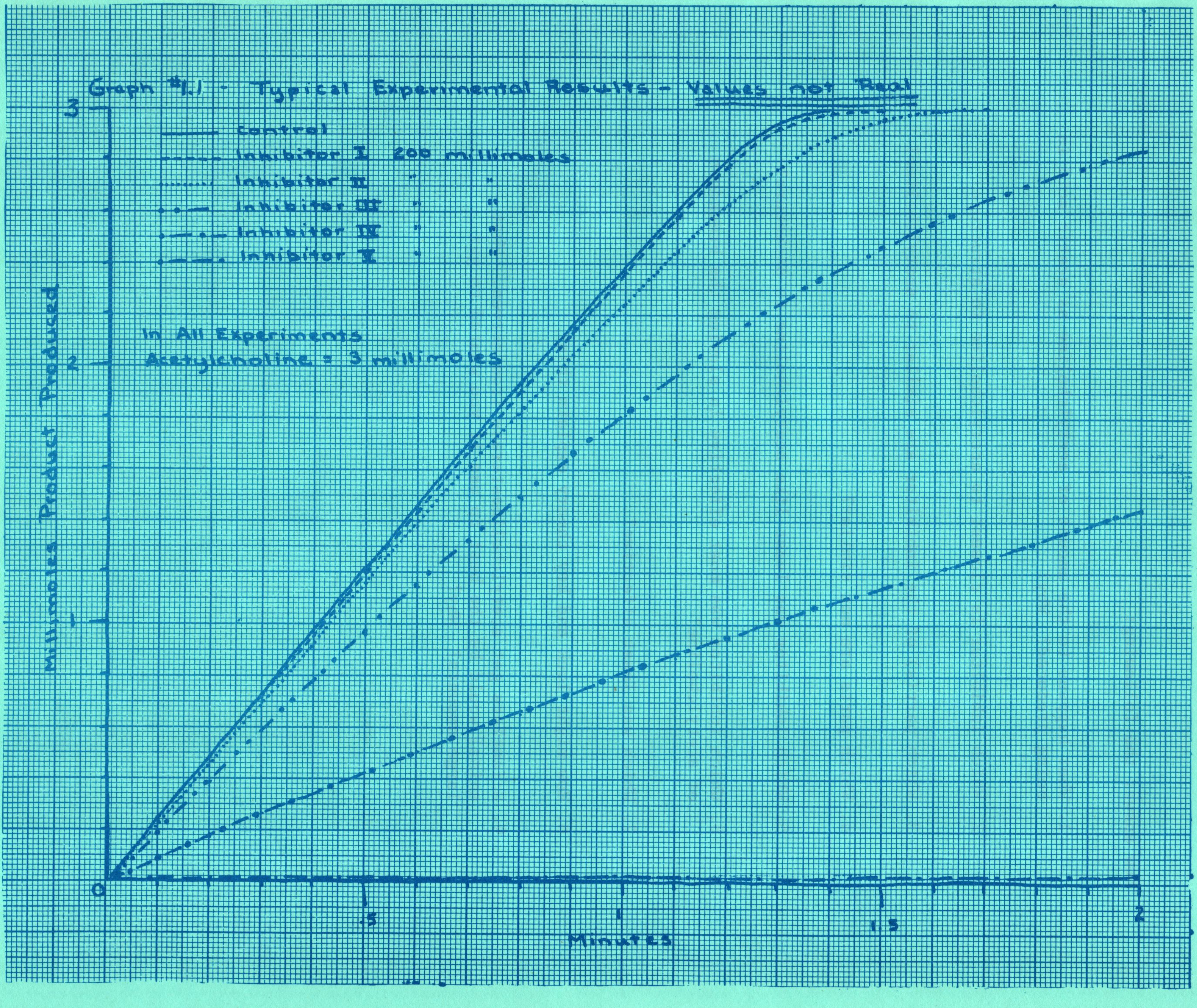
Either data format will give you good results. The table will print out the amount of acetylcholine remaining at the end of each tenth of a minute and the total acetic acid produced up to that time. The inhibitor concentration remaining at the end of the experiment will also be printed. The graph will yield a plot of the amount of acetic acid produced vs. the time (in tenths of a minute) since the onset of the reaction, with the amount of acetic acid produced (in millimoles) printed next to the appropriate point. Again, the inhibitor concentration at the end of the experiment will be printed.

If an experiment does not run to completion within two minutes, the computer will ask, "Do you want to continue the assay?" Type "1" if you want to continue the experiment; "0" otherwise.

How to analyze your data. When you think you have finished experiments with each of the five inhibitors and the control, it will be necessary to compile your data in one graph:

1. Put acetic acid concentration (0 to 3 millimoles) on the vertical (y) axis.
2. Put time (from 0 to 2 minutes) on the horizontal (x) axis.
3. Plot your data from the control experiment, connect the points with a smooth line, and label the control.
4. Plot data for each of the inhibitors on the same graph. Be sure to label each line with the inhibitor code number.

Graph 1.1 is an example, but be careful -- Graph 1.1 is wrong.



Graph #1.1 - Typical Experimental Results - Values not Real

Now answer the following:

1. What happens to the amount of acetylcholine as acetic acid is being produced? Why?

2. Which inhibitor is closest to acetylcholine in structure?

3. Which part(s) of the inhibitor are similar to acetylcholine?

4. Which parts are not similar?

5. Which inhibitor was least like acetylcholine in structure?

6. Which inhibitor was most effective in slowing the breakdown of acetylcholine?

7. Which was least effective?

8. How might lock and key theory explain this?

9. Scientists get acetylcholinesterase from nerves. What animal would be the best to use if you wanted to get large amounts? Why?

COMPUTER INPUT SHEET

	Amount of Acetylcholine	Type of Inhibitor See p. 3 for code	Amount of Inhibitor
CONTROL	___ millimoles	Code # 0	0 millimoles
Exp. # 1	___ millimoles	Code # ___	___ millimoles
Exp. # 2	___ millimoles	Code # ___	___ millimoles
Exp. # 3	___ millimoles	Code # ___	___ millimoles
Exp. # 4	___ millimoles	Code # ___	___ millimoles
Exp. # 5	___ millimoles	Code # ___	___ millimoles
	Possible range: 0-3 millimoles		Possible range: 0 up to infinity